PATENT
8733.036.21

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re application of

Komatsu HIROSHI	Group Art Unit: **2871**
Application No.: **To Be Assigned**	Examiner: **M. Ton**
Date Filed: **October 22, 2001**	
For: **Liquid Crystal Display**	

PRELIMINARY AMENDMENT

Commissioner of Patents
Washington, D.C. 20032
Sir:

Preliminary to the examination of the above-identified application, the following amendments and remarks are respectfully requested.

IN THE ABSTRACT:

Please **AMEND** the Abstract of the Disclosure to read as follows (Exhibit I is a marked up version of the amended Abstract):

ABSTRACT OF THE DISCLOSURE

A liquid crystal display including: a first transparent substrate coated with a first alignment layer, a second transparent substrate coated with a second alignment layer, the second substrate facing the first transparent substrate, a liquid crystal layer between the substrates, a polarizer attached on the outer surfaces of the substrates, a pair of electrodes formed on the first substrates, and a driving circuit applying signal voltage to the electrodes. The liquid crystal molecules adjacent to the first substrate is rotated by applying the voltage, but, the liquid crystal molecule adjacent to the second substrate is fixed regardless of the

applied voltage. The electrode pair, substantially straight data and common electrodes, are inclined at an angle with respect to a gate line.

IN THE SPECIFICATION:

Please **AMEND** the Specification to read as follows (Exhibit II is a marked up version of the amended Specification):

Page 2, after the first paragraph, insert the following paragraph:

This application is a continuation of Application No. 09/365,634, filed August 3, 1999, which is a continuation of Application No. 08/832,980, filed April 4, 1997.

Page 2, paragraphs three and four, starting with line 10.

Conventional TFT LDCs (thin film transistor liquid crystal display) have a drawback known as a viewing angle dependency, that is, the contrast ratio is changed according to the viewing angle. This has made it difficult to apply the technology to a large size display.

To solve this problem, various liquid crystal displays have been proposed, such as a retardation attaching TNLCD (twisted nematic liquid crystal display) and a multi-domain liquid crystal display. The LCDs still have other technical problems such as complicated production process and shifting color tones.

Page 3, paragraph one, starting with line 2.

Recently, an IPS LCD has been introduced to obtain a wide viewing angle. This technology is discussed in JAPAN DISPLAY 92, p547, Japanese patent application No. 7-36058, Japanese patent application No. 7-225538, and ASIA DISPLAY 95, p707. As shown in FIG. 1a and FIG. 1c, in the liquid crystal layer 12 the molecules are aligned at a 45° angle. The principal transmittance axis of a polarizer 9 attached to the first substrate 1 is the same

direction as the alignment direction of the liquid crystal 12, and the principal transmittance direction of an analyzer 10 attached to the second substrate 5 is perpendicular to the alignment direction of the liquid crystal layer 12. A pair of electrodes 2, 3 is formed on the first substrate 1.

Page 5, after the last paragraph, insert the following paragraph starting on line 22.

A liquid crystal display device comprises a first substrate; a transistor formed over the first substrate, the transistor including a gate electrode, a source electrode and a drain electrode; a data line formed over the first substrate the data line being connected to the source electrode; a common electrode formed over the first substrate, the common electrode including a plurality of spaced apart parallel common projections formed in a first direction; a data electrode formed over the first substrate and connected to the drain electrode, the date electrode including a plurality of spaced apart parallel data portions formed in a second direction and interleaved between the common projections, the first direction being parallel to the second direction; an insulating layer formed over the common projections and under the data portions; and a gate line formed over the first substrate, the gate line being connected to the gate electrode.

Page 6, paragraph five, starting with line16.

FIG. 4a shows a plan view of the liquid crystal display according to the present invention, and Fig. 4b shows a cross-section of the device taken along the line IV-IV of Fig. 4a;

Page 8, paragraph two, starting with line 12.

The liquid crystal molecules 78 will be twisted between the two substrates 26, 27 by applying the driving voltage to the electrodes 48, 49. The distance between two adjacent electrodes 48, 49 is less than the thickness of the liquid crystal layer 60. The retardation value is calculated by following formula:

$$\lambda/2 < \Delta nd \leq \lambda.$$

Page 9, paragraph one, starting with line 3.

FIG. 3 shows optical axes of the liquid crystal display according to the present invention. θ_{EL} is represented as the extension direction of the electrodes 48 and 59, θ_{FE} is the electric field direction applied by the electrodes, θ_{LC1} is the optical axis direction of the liquid crystal molecules adjacent to the first substrate and θ_{LC2} is the optical axis direction of the liquid crystal molecules adjacent to the second substrate when the voltage is not applied. θ_{PL1} is the principal transmission axis of a polarizer, θ_{PL2} is the principal transmission axis of an analyzer, θ_{LC1} is the optical axis direction of the liquid crystal molecules adjacent to the first substrate when the voltage is applied. The alignment direction θ_{LC1} of the first substrate is anti-parallel to the alignment direction θ_{LC2} of the second substrate, and the principal transmission axis θ_{PL2} of the analyzer is parallel to the alignment direction θ_{LC1}, θ_{LC2}. In addition, the principle transmission axis θ_{PL1} of the polarizer is perpendicular to the principal transmission axis θ_{PL2} of the analyzer.

Page 10, paragraph one, starting with line 3.

By forming the electrodes on the slant, when the voltage is not applied, all of the liquid crystal molecules between the two alignment layers 59, 62 are aligned parallel to the substrates 26, 27 and to the principal transmission axis θ_{PL2} of analyzer. Therefore, the

viewing angle inverted areas appear at the corners of the display so that the inverted phenomenon is not remarkable. The liquid crystal is nematic without the need to mix a chiral dopant. The LCD shown in FIG. 2(a) is a normally black mode because the polarizer and the analyzer are crossed and the liquid crystal molecules between them are parallel to one another.

<u>Page 11, paragraph one, starting with line 3.</u>

electric field is weaker as the distance increases from the first substrate formed with electrodes 48 and 49. The irregularities in the electric filed can be achieved by making the thickness of the liquid crystal layer greater than the interval between two electrodes.

<u>Page 13, paragraph one, starting with line 1.</u>

$\Delta nd=(85°/90°)\lambda=0.94$. The dielectric anisotrophy Δn and the thickness d of the liquid crystal are appropriately arranged. The dielectric anisotrophy of the liquid crystal generally used in TN mode is 0.06-0.08, and the wave length of the light is 0.56μm. When the values are substituted in the above formula, the thickness d should be 6.0-8.8μm.

<u>Page 16, paragraph two, starting with line 16.</u>

In the above structure, the extension line θ_{EL} is disposed 95° relative to the horizontal line (0°), such that the electric filed direction θ_{FE} is 5°. The extension line is extended from the 5μm width data electrode 48 and the 5μm width common electrode 49, which are parallel to each other with a 5μm space therebetween.

<u>Page 17, paragraph one, starting with line 1.</u>

to a thickness of about 8μm and baking. The alignment layer 59 coated on the first substrate 27 is rubbed in the -90° direction, and the alignment layer 62 coated on the second substrate 26 is rubbed in the 90° direction. The spacer 65 can be formed from Micropal

(produced in SEKISUI FINE CHEMICAL CO.) with an exemplary 8.0μm diameter, to maintain the liquid crystal layer 60 with a mean thickness of 7.8μm. The liquid crystal material can be ZGS 5025 (Δn=0.067; Δ ϵ=6.0; produced by CHISSO CO.). The pretilt angle of the liquid crystal is 4.8°, and the retardation value Δnd is 0.41.

The principal transmittance axis of the polarizer 63 attached on the first substrate 27 is the horizontal direction (θ_{PL1}=0°) and that of the analyzer 64 attached on the second substrate 26 is the vertical direction (θ_{PL2}=90°).

Page 19, paragraph one, starting with line 5.

The rotation angle of the liquid crystal layer is detected by an evaluator for LCD (produced in NIHON DENSHI CO.). The results show that the liquid crystal molecules 1 μm distant from the second substrate 26 have a optic axis of 88°, and the liquid crystal molecules 1 μm distant from to the first substrate 27 have a optic axis of 19°. It can be understood that the alignment direction of the liquid crystal molecules near the first substrate 26 is almost fixed, but the alignment direction of the liquid crystal molecules near the first substrate 27 is rotated about the anticipated angle. At this position, the anticipated angle of the liquid crystal molecules is 16. Therefore, the liquid crystal molecule is twisted in the liquid crystal layer.

Page 20, paragraph one, starting with line 1.

The embodiments of the present invention have been described as having a 95° electrode extension line as an example. However, the direction can be selected according to the viewing angle characteristics that are required.

IN THE CLAIMS:

Please cancel claims 2-27 without prejudice or disclaimer of the subject matter contained therein.

REMARKS

Claim 1 is now pending in the present application. Claims 2-27 have been cancelled without prejudice. Examination and consideration of the application, as amended, are respectfully requested.

If these papers are not considered timely filed by the Patent and Trademark Office, then a petition is hereby made under 37 C.F.R. §1.136, and any additional fees required under 37 C.F.R. §1.136 for any necessary extension of time, or any other fees required to complete the filing of this response, may be charged to Deposit Account No. 50-0911 (8733.036.21). Please credit any overpayment to deposit Account No. 50-0911. A duplicate copy of this sheet is enclosed.

Respectfully submitted,

LONG, ALDRIDGE & NORMAN, LLP

SKJ/dlt

By:____________________
Song K. Jung
Reg. No. 35,210

Date: October 22, 2001
701 Pennsylvania Avenue, N.W.
Sixth Floor, Suite 600
Washington, D.C. 20004
Telephone No.: (202) 624-1200
Facsimile No.: (202) 624-1298

ATTACHMENTS: Exhibit I: Marked-up Version of the Abstract of the Disclosure
Exhibit II: Marked-up Version of the Specification

A liquid crystal display including: a first transparent substrate coated with a first alignment layer, a second transparent substrate coated with a second alignment layer, the second substrate facing the first transparent substrate, a liquid crystal layer between the substrates, a polarizer attached on the outer surfaces of the substrates, a pair of electrodes formed on the first substrates, and a driving circuit applying signal voltage to the electrodes. The liquid crystal molecules adjacent to the first substrate is rotated by applying the voltage, but, the liquid crystal molecule adjacent to the second substrate is fixed regardless of the applied voltage. The electrode pair, substantially straight data and common electrodes, are inclined at an angle with respect to a gate line.

EXHIBIT II

MARKED UP VERSION OF THE SPECIFICATION

Page 2, paragraphs 3 and 4, starting with line 10.

Conventional TFT LDCs (thin film transistor liquid crystal display) [has] have a drawback known as a viewing angle dependency, that is, the contrast ratio is changed according to the viewing angle. This has made it difficult to apply the technology to a large size display.

To solve this problem, various liquid crystal displays [are] have been proposed, such as a retardation attaching TNLCD (twisted nematic liquid crystal display) and a multi-domain liquid crystal display. The LCDs still have other technical problems such as complicated production process and shifting color tones.

Page 3, first paragraph, starting with line 2.

Recently, an IPS LCD has been introduced to obtain a wide viewing angle. This technology is discussed in JAPAN DISPLAY 92, p547, Japanese patent application No. 7-36058, Japanese patent application No. 7-225538, and ASIA DISPLAY 95, p707. As shown in FIG. 1a and FIG. 1c, in the liquid crystal layer 12 the molecules are aligned at a 45° angle. The [principle] principal transmittance axis of a polarizer 9 attached to the first substrate 1 is the same direction as the alignment direction of the liquid crystal 12, and the [principle] principal transmittance direction of an analyzer 10 attached to the second substrate 5 is perpendicular to the alignment direction of the liquid crystal layer 12. A pair of electrodes 2, 3 is formed on the first substrate 1.

Page 6, paragraph 5, starting with line16.

FIG. 4a shows a plan view of the liquid crystal display according to the present invention, and Fig. 4b shows a cross-section of the device taken along the line [IVA-IVA] IV-IV of Fig. 4a;

Page 8, paragraph two, starting with line 12.

The liquid crystal molecules [60] 78 will be twisted between the two substrates 26, 27 by applying the driving voltage to the electrodes 48, 49. The distance between two adjacent electrodes 48, 49 is less than the thickness of the liquid crystal layer 60. The retardation value is calculated by following formula:

Page 9, paragraph one, starting with line 3.

FIG. 3 shows optical axes of the liquid crystal display according to the present invention. θ_{EL} is represented as the extension direction of the electrodes 48 and 59, θ_{FE} is the electric field direction applied by the electrodes, θ_{LC1} is the optical axis direction of the liquid crystal molecules adjacent to the first substrate and θ_{LC2} is the optical axis direction of the liquid crystal molecules adjacent to the second substrate when the voltage is not applied. θ_{PL1} is the [principle] principal transmission axis of a polarizer, θ_{PL2} is the [principle] principal transmission axis of an analyzer, θ_{LC1} is the optical axis direction of the liquid crystal molecules adjacent to the first substrate when the voltage is applied. The alignment direction θ_{LC1} of the first substrate is anti-parallel to the alignment direction θ_{LC2} of the second substrate, and the [principle] principal transmission axis θ_{PL2} of the analyzer is parallel to the alignment direction θ_{LC1}, θ_{LC2}. In addition, the principle transmission axis θ_{PL1} of the polarizer is perpendicular to the [principle] principal transmission axis θ_{PL2} of the analyzer.

<u>Page 10, paragraph one, starting with line 3</u>.

By forming the electrodes on the slant, when the voltage is not applied, all of the liquid crystal molecules between the two alignment layers 59, 62 are aligned parallel to the substrates 26, 27 and to the [principle] <u>principal</u> transmission axis θ_{PL2} of analyzer. Therefore, the viewing angle inverted areas appear at the corners of the display so that the inverted phenomenon is not remarkable. The liquid crystal is nematic without the need to mix a chiral dopant. The LCD shown in FIG. 2(a) is a normally black mode because the polarizer and the analyzer are crossed and the liquid crystal molecules between them are parallel to one another.

<u>Page 11, paragraph one, starting with line 3</u>.

electric field is weaker as the distance increases from the first substrate formed with electrodes 48 and 49. [Irregularities] <u>The irregularities</u> in the electric filed can be [avoided] <u>achieved</u> by making the thickness of the liquid crystal layer greater than the interval between two electrodes.

<u>Page 13, paragraph one, starting with line 1</u>.

[$\Delta nd=0.74\lambda$] <u>$\Delta nd=(85°/90°)\lambda=0.94$</u>. The dielectric anisotrophy Δn and the thickness d of the liquid crystal are appropriately arranged. The dielectric anisotrophy of the liquid crystal generally used in TN mode is 0.06-0.08, and the wave length of the light is 0.56μm. When the values are substituted in the above formula, the thickness d should be [5.0-7.0] <u>6.0-8.8μm</u>.

<u>Page 16, paragraph two, starting with line 16</u>.

In the above structure, the extension line θ_{EL} is disposed 95° relative to the horizontal line [(0°)] <u>(0°)</u>, such that the electric filed direction θ_{FE} is 5°. The extension line is extended

from the 5μm width data electrode 48 and the 5μm width common electrode 49, which are parallel to each other with a 5μm space therebetween.

Page 17, paragraph one, starting with line 1.

to a thickness of about 8μm and baking. The alignment layer 59 coated on the first substrate 27 is rubbed in the -90° direction, and the alignment layer 62 coated on the second substrate 26 is rubbed in the 90° direction. The spacer 65 can be formed from Micropal (produced in SEKISUI FINE CHEMICAL CO.) with an exemplary [6.4] 8.0μm diameter, to maintain the liquid crystal layer 60 with a mean thickness of [6.2] 7.8μm. The liquid crystal material can be ZGS 5025 (Δn=0.067; $\Delta \epsilon$=6.0; produced by CHISSO CO.). The pretilt angle of the liquid crystal is 4.8°, and the retardation value Δnd is 0.41.

The [principle] principal transmittance axis of the polarizer 63 attached on the first substrate 27 is the horizontal direction (θ_{PL1}=0°) and that of the analyzer 64 attached on the second substrate 26 is the vertical direction (θ_{PL2}=90°).

Page 19, paragraph one, starting with line 5.

The rotation angle of the liquid crystal layer is detected by an evaluator for LCD (produced in NIHON DENSHI CO.). The results show that the liquid crystal molecules [adjacent] 1µm distant from the second substrate 26 have a [transmittance] optic axis of 88°, and the liquid crystal molecules [adjacent to] 1µm distant from to the first substrate 27 have a [transmittance] optic axis of 19°. It can be understood that the alignment direction of the liquid crystal molecules near the first substrate 26 is almost fixed, but the alignment direction of the liquid crystal molecules near the first substrate 27 is rotated about the anticipated angle [of 16°]. At this position, the anticipated angle of the liquid crystal molecules is 16. Therefore, the liquid crystal molecule is twisted in the liquid crystal layer.

Page 20, paragraph one, starting with line 1.

The embodiments of the present invention have been described as having a 95° [electric field] electrode extension line as an example. However, the direction can be selected according to the viewing angle characteristics that are required.